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(54) Abrasive articles

(57) An abrasive article comprising a substrate of cellular material with a pair of major planar surfaces,

a compressible mat of nonwoven fibres affixed to one of said major surfaces, said fibres having adhered thereto abrasive particles,
a coated abrasive layer comprising abrasive particles,
and a binder bonded to said other major surface.

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Description

The invention relates to an abrasive article and in particular to an abrasive article comprising a foamed plastic substrate, one side of which bears a coating of abrasive mineral, and the other side of which is laminated to a layer of nonwoven web abrasive. The article usefully combines two types of abrasive action in a single product.

In the preparation of surfaces for painting, especially surfaces of wood, plaster etc as commonly found on interior walls, at least three separate processes can be identified. Firstly, there is a relatively aggressive abrading process whereby surface defects are corrected, for example bumps may be sanded down, excess filler removed from repaired holes and cracks, damaged or unwanted paint layers removed etc. Secondly, there is a mild abrasive process whereby a basically sound surface is roughened slightly to provide a mechanical key for the new coat of paint. Thirdly, there is a cleaning process whereby grease, dust or other loosely-adhered debris are removed immediately prior to the application of the new coating of paint. Since these processes call for different degrees of abrasive action, and since some are performed dry and others wet, it is normal practice for painters and decorators to employ two or more tools for the job. This is inconvenient and leads to reduced productivity, especially when working from a ladder or other raised platform. There is therefore a need for a single abrasive tool suitable for all the stages of surface preparation.

GB-A-840484 discloses scouring pads comprising a sheet or block of foam having an abrasive layer secured to at least one face. A pad may have one abrasive layer of coarser particles and another of finer particles.

GB-A-955713 discloses a cleaning device comprising two cleaning or abrasive pads, which may be of dissimilar materials, secured back to back and a flexible strap-like handle.

US-A-4856134 discloses an abrasive pad comprising a foam block and two non-woven webs sandwiching the block therebetween.

US-A-5140785 discloses a block including several different pads attached to a flexible connecting sheet that permits superimposing the pad in at least two different configurations so that the surfaces of different pads define the outer surfaces of the block.

"Direct-coated" sponge abrasives are those in which abrasive mineral is coated on the surface of a resilient, cellular (sponge) material, such as foamed plastic, together with the relevant adhesives and binders. Although one or more resin layers may be coated on the foam prior to coating the abrasive, it is the foam itself which provides the overall structural integrity of the finished article, and largely determines its bulk physical properties such as tensile strength, flexibility, elasticity, etc.

Direct-coated sponge abrasives are distinct from laminated-sponge abrasives in which abrasive mineral is bonded to one surface of a backing, such as paper or cloth, the other surface being laminated to a layer of sponge material. Direct-coated sponge abrasives show several advantages, including reduced raw material costs and an improved performance in terms of the smoothness of finish for a given rate of cut.

Direct-coating of abrasive on to sponge materials is disclosed in numerous patents, e.g., US-A-4,966,609, 4,629,473, 4,038,047, and 3,607,159, and GB 1,597,455 and 1,472,087. A commercially available example is sold by Minnesota Mining and Manufacturing Company under the product numbers 03808, 03809 and 03810.

Nonwoven abrasive materials are well known in the literature and in the marketplace and are disclosed, for example, in GB 1014297 and US-A-5152809. Such materials comprise a lofty nonwoven web of fibres (usually of a synthetic thermoplastic polymer) bonded at their points of contact by melt fusion or by means of a suitable resin. Abrasive particles may be distributed within this matrix and resin-bonded to the individual fibres. Such materials are sold by Minnesota Mining and Manufacturing Company in a variety of grades under the trademark "Scotchbrite", and are widely used in industry and the home for purposes of cleaning and surface conditioning.

Many products available on the market comprise a layer of sponge or cellular material (generally at least 2 cm thick) laminated to a layer of nonwoven abrasive. Such products are designed for cleaning hard, nonporous surfaces, as in the cleaning of glassware, crockery, kitchen utensils, sinks, baths, worktops etc. The nonwoven abrasive is used to dislodge dirt and foreign matter from the surface being cleaned, while the sponge layer acts as a reservoir for water and soap or detergent to assist in the cleaning process, and (after wringing out) can be used to mop up excess water and suspended debris. The sponge layer does not exert any abrasive action.

US-A-5,109,637 discloses an implement having a flexible core, which may be a foam, to which compressible, resilient and flexible fibre mats bearing fine abrasive material are secured to form a tool that can conveniently conform or coincide with convex, concave, flat or curved surfaces and to corners and crevices to enable improved, easier cleaning and smoothing of relatively soft greenware without damage to the surface. The tool can be an elongated member with parallel working surfaces or it can be a cylindrical, conical or other shape for adaptation to special requirements.

US-A-4343910 discloses a polishing article comprising a foam layer containing finely divided abrasive particles distributed throughout, with some of the particles being exposed on the surface of the foam layer, in which the foam layer is affixed a plastic base by an adhesive layer and a crocus cloth layer comprised of

finely divided iron oxide is affixed to the other side of the base by an adhesive layer.

The present invention provides an abrasive article comprising a sponge layer having a coated abrasive and a nonwoven layer, both of which exert an abrasive action, which can be used both wet and dry, and finds use on surfaces which may be of a porous or flaky nature.

According to the patent invention there is provided an abrasive article comprising a substrate of cellular material with a pair of major planar surfaces,

a compressible mat of nonwoven fibres affixed to one of said major surfaces, said fibres having adhered thereto abrasive particles,
a coated abrasive layer comprising abrasive particles,
and a binder bonded to said other major surface.

The substrate may comprise any sponge material suitable for use as an abrasive backing, including both open-cell and closed-cell materials, such as those disclosed in US-A-4,966,609, 4,629,473, 4,038,047, and 3,607,159 and GB 1,597,455, and 1,472,087. In a preferred embodiment of the invention, the substrate comprises a sheet of open-cell polyester-urethane foam of density 50 to 100 kg/m^3 and thickness 2 to 15 mm, more preferably about 4 mm in thickness. This is considerably thinner than the foam layers commonly used in cleaning pads comprising a sponge/nonwoven laminate.

One major surface of the substrate bears a layer of abrasive particles and at least one binder resin. The layer does not comprise a web of fibres. It is preferred the coated abrasive layer is bonded to the substrate without use of an intermediate backing material.

In the simplest embodiments, this may comprise a single layer of cured adhesive resin in which abrasive particles are partially embedded. In preferred embodiments, however, the abrasive coating comprises (in sequence) a "pre-size" resin layer which seals the surface of the foam substrate, a "make" resin layer which secures abrasive particles to the substrate, a "size" resin layer which controls the extent to which the abrasive particles project above the surface of the abrasive coating, and a "supersize" layer which confers antiloading properties on the finished article.

Suitable presizes may be applied to a surface of the foam substrate (in the form of a continuous web) as solvent- or water-based formulations, or as 100% solids hot melt formulations. Hot melt formulations are preferred, and suitable resins for this use include those commercially available under the trade names "Thermaflow 6876" (a hot melt ethylene/vinyl acetate copolymer from Evode), "3M 3748" and "3M3789" (respectively, a hot melt polyethylene and a hot melt polyamide from 3M).

Suitable make resins include any of the thermosetting or photocurable resins known in the art of abrasive coatings. These include phenol-formaldehyde, urea-formaldehyde and melamine-formaldehyde resins, epoxy resins, acrylate resins, aminoplast resins and urethane resins, including mixtures and/or modified versions of these. Make resins of these types may be applied to the substrate as solvent- or water-based formulations by any of the standard coating techniques. However, in preferred embodiments of the invention, the make resin comprises a moisture-curable hot melt adhesive, applied as a 100% solids formulation. Hot melt adhesives suitable for use in this way include moisture-curable polyurethanes such as those available under the tradenames Tivomelt 9617/11, 9628 and 9635/12 from Tivoli, Purmelt QR116 and QR3310-21 from Henkel, and Jet Weld TS-230 from 3M; and moisture-curable silane-functional hot melts such as X200/9 (TM), available from Swift Adhesives Ltd (Twickenham, UK), as described in UK Patent Appln. Nos. 9316715.3 and 9416179.1 respectively. When a hot melt make resin is used in conjunction with a hot melt presize, both resins may be extruded onto the substrate in a single pass.

Essentially any conventional type of abrasive particle may be embedded in the make adhesive, including silicon dioxide, silicon carbide, aluminium oxide, white aluminium oxide, ceramic aluminium oxide, cerium oxide, fused alumina-zirconia, diamond, cubic boron nitride etc. Preferred grit sizes are in the range P36 to P1000. The abrasive particles are preferably coated subsequent to coating the make resin but while the latter is still in a molten, semi-molten or tacky state so that the particles become embedded therein. Preferably, the abrasive particles are applied to the make coating by the electrostatic coating methods commonly used in the abrasives industry, which impart a degree of orientation to the particles. However, other methods such as drop coating may also be used. Alternatively, a slurry of make resin and abrasive grains may be coated directly on the substrate.

A size layer is preferably coated above the make resin (after the latter has at least partially cured or hardened) in order to provide further anchorage of the abrasive grains, and to control the height of their projection above the surface of the coated layers. Any of the resins suitable for use as make resins may be used for sizing purposes, water-based formulations of urea-formaldehyde resins being preferred. The size layer may incorporate antiloading additives, but these are more preferably applied as an outer, super-size layer. For example, the supersize may comprise an antiloading coating. Antiloading additives are compounds or mixtures of compounds which reduce the tendency of the finished article to "load" during use, i.e., become clogged with dust and debris and hence lose its abrasive properties. This can be a particular problem when dry-sanding paint surfaces. Suitable antiloading additives include salts of fatty acids (especially stearates) and fluorochemicals (as disclosed in US 5,164,265), and a preferred antiloading supersize comprises an aqueous dispersion (approx. 30% solids) or a mixture comprising calcium stearate (Nopco EC 769 from Hen-

kel, 210 parts by wt), Vinacryl 71322 (a water-based acrylic dispersion from Vinyl Products Ltd, 40 parts by wt) and FC396 (TM) (a fluorochemical compound available from Minnesota Mining and Manufacturing Company, 2 parts by wt), spray coated to a dry weight of 20 to 30 g/m^2.

On the other major surface of the cellular substrate there is laminated a layer of nonwoven abrasive material. The latter comprises an open, lofty nonwoven web of synthetic fibres bonded at their points of contact by means of a resin or by melt fusion. Abrasive particles are secured to the fibres by means of a suitable binder resin. Preferred fibres are crimped, staple, synthetic organic fibres such as polyester fibres and nylon fibres, which may be processed and entangled into nonwoven webs by conventional web-forming machines such as that sold under the tradename "Rando Webber" through Rando Machine Company of New York, as described for example in US-A-2,958,593 and 3,537,121. The resulting web may be heated to bring about melt-bonding of the fibres at their points of contact, and/or treated (by spraying, roll-coating etc) with a liquid resinous composition which (after drying and curing) bonds the fibres together at their points of contact.

Abrasive particles may be present as a dispersion in the aforesaid liquid resinous composition, or they may be applied to the web as a dispersion in a separate binder formulation. Suitable abrasive particles range in average diameter of from 0.001 to about 1mm, preferably 0.01 to 0.5mm, and may be selected from a wide range of materials including those abrasive materials described above with reference to the coated abrasive layer. Generally, the abrasive particles in the non-woven layer are selected from garnet, flint, silica, pumice, calcium carbonate, silicon carbide, corundum, aluminium oxide, fused alumina-zirconia, boron nitride, tungsten carbide, silicon carbide, glass bubbles, glass beads and iron particles as well as particles of organic resins such as polyesters, polycarbonates, polyacrylates and methacrylates etc. Mixtures of different abrasive particles may be used.

Detailed descriptions of the manufacture of nonwoven abrasive materials are disclosed, for example, in US-A-5,030,496.

Suitable nonwoven abrasives are available commercially in a variety of thicknesses, densities and abrasive powers under the tradename "Scotchbrite" from Minnesota Mining and Manufacturing Company. A particularly suitable grade is that designated "5447", which has a layer thickness of about 5 mm and a basis weight in the range 200 to 250 g/m^2.

The layer of nonwoven abrasive is typically bonded to the cellular substrate by means of a suitable adhesive. A variety of adhesives may be used, including solvent-based adhesives, 100% solids hot melt adhesives etc, but a preferred adhesive is a two-part polyurethane type adhesive comprising equal parts of "Desmophene 1800" and "Desmodur L75", both available from Bayer. The layer of nonwoven abrasive is most conveniently laminated to the cellular substrate as a continuous web, using conventional web handling techniques, subsequent to the coating of abrasive grains on the other major surface of the substrate.

The invention will now be described with reference to the accompanying drawing which represents a cross-section through an abrasive article of the invention.

The abrasive article comprises a substrate (2) of cellular material e.g. foamed plastic substrate. The substrate may have any desired shape e.g. square, rectangular, circular, hexagonal etc. Preferably the substrate is a polyester-urethane foam of about 4 mm thickness.

A compressible mat (4) of nonwoven fibres having abrasive particles adhered to the fibres is bonded to one major surface of the substrate (2) by adhesive layer (6). The mat (4) preferably comprises a layer of about 5 mm thickness of Scotchbrite 5447 nonwoven abrasive bonded by a hot melt or polyurethane adhesive.

The other major surface of the substrate (2) is bonded to an abrasive layer (8) without the use of a backing material. The abrasive layer (8) is direct coated on the substrate and comprises one or more binders (12) in which abrasive particles (10) are embedded. The abrasive layer is preferably formed of a pre-size layer, make resin layer and a size layer and optionally a supersize layer.

The abrasive articles of the invention find use in a variety of cleaning, sanding and surface conditioning processes. The presence in the same article of two types of abrasive, both of which may be used wet or dry, provides enhanced versatility. The articles are highly durable, yet are highly flexible and resilient, which enables them to conform to curved or irregular surfaces.

A particular area of utility is in the preparation of surfaces, especially wood, plaster etc, for painting. The direct coated side is particularly suitable for removing old paint and surface irregularities (which is normally carried out under dry conditions), while the nonwoven side is particularly suitable for finishing the surface left in the first operation and for roughening otherwise sound, glossy surfaces. The latter operation may be carried out under wet conditions so that final traces of dust and grease are removed, leaving the surface ready for painting once dry. Cleaning agents, such as microencapsulated soaps, detergents, ammonia etc, may optionally be incorporated in the nonwoven layer to assist with the degreasing process. The ability to perform all these aspects of surface preparation with a single tool is a unique feature of the invention, and greatly enhances productivity.

Claims

1. An abrasive article comprising a substrate of cellular material with a pair of major planar surfaces,

   a compressible mat of nonwoven fibres affixed to one of said major surfaces, said fibres having adhered thereto abrasive particles,

a coated abrasive layer comprising abrasive particles,
and a binder bonded to said other major surface.

2. An abrasive article as claimed in Claim 1 in which the substrate comprises an open-cell foam of density 50 to 100 kg/m^3 and thickness of from 2 to 15 mm.

3. An abrasive article as claimed in Claim 1 or Claim 2 in which the substrate has a thickness of about 4 mm.

4. An abrasive article as claimed in any preceding Claim in which the substrate comprises polyesterurethane foam.

5. An abrasive article as claimed in any preceding Claim in which the coated abrasive layer comprises abrasive particles selected from silicon dioxide, silicon carbide, aluminium oxide, white aluminium oxide, ceramic aluminium oxide, cerium oxide, fused alumina zirconia, cubic boron nitrate and mixtures thereof.

6. An abrasive article as claimed in any preceding Claim in which the grit size of the abrasive particles of the coated abrasive layer is in the range P36 to P1000.

7. An abrasive article as claimed in any preceding Claim in which the coated abrasive layer comprises a make resin layer and a size resin layer, the make and/or size resin being selected from phenol-formaldehyde, ureaformaldehyde, melamine formaldehyde, epoxy, acrylate and urea resins and mixtures and modified versions thereof.

8. An abrasive article as claimed in Claim 7 in which the abrasive layer additionally comprises a supersize layer which contains calcium stearate and/or a fluorochemical.

9. An abrasive article as claimed in Claim 7 or Claim 8 in which the abrasive layer comprises a pre-size resin layer comprising a hot melt ethylene/vinyl acetate copolymer, a hot melt polyethylene or a hot melt polyamide to seal the surface of the substrate.

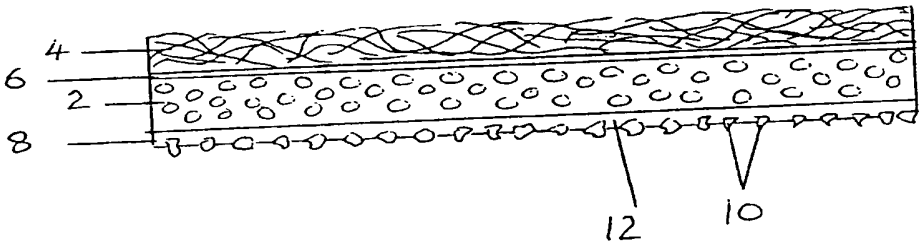
10. An abrasive article as claimed in any preceding Claim in which the compressible mat comprises an open, lofty nonwoven web of synthetic fibres bonded at their points of contact by means of a resin or by melt fusion.

11. An abrasive article as claimed in Claim 10 in which the synthetic fibres are crimped, staple fibres of polyester and/or nylon.

12. An abrasive article as claimed in any preceding Claim in which the abrasive particles adhered to fibres of the compressible mat are selected from garnet, flint, silica, pumice, calcium carbonate, silicon carbide, corundum, aluminium oxide, fused alumina-zirconia, boron nitride, tungsten carbide, silicon carbide, glass bubbles, glass beads, iron particles and particles of organic resins selected from polyester, polycarbonate, polyacrylate and polymethacrylate.

13. An abrasive article as claimed in Claim 12 in which said abrasive particles have an average diameter of from 0.001 to 1mm.

14. An abrasive article as claimed in any preceding Claim in which the compressible mat has a thickness of about 5 mm.



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EUROPEAN SEARCH REPORT

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DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 3 976 525 A (EDWARD MEDNICK) * the whole document * ---	1-5,7, 10-12,14	B24D3/26 B24D3/32 B24D15/04 A47L17/08
X	DE 39 03 204 A (PETER JÖST) * the whole document * ---	1,10	B24D3/28 B24D11/02
A	US 3 732 652 A (HENRY P. FURGAL ET AL.) * the whole document * * column 2, line 31 - line 60; claim 3; figure 3 * ---	1-5, 10-12	
A	US 4 352 846 A (MICHAEL PÄSSLER ET AL.) * the whole document * ---	1,10	
A	GB 2 189 802 A (VEB INDUSTRIEBÜRSTEN BERLIN) * the whole document * ---	1-4,10, 11	
A	EP 0 464 850 A (NORTON COMPANY) * the whole document * * page 2, line 39 - line 58 * * page 3, line 23 - line 46 * * claims 1,7,9,11,14 * ---	1,5-13	TECHNICAL FIELDS SEARCHED (Int.Cl.6) B24D A47L B32B
A	WO 92 01536 A (GIGI PRODUCTS, INC.) * the whole document * & US 5 152 809 A -----	1-7, 10-14	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 July 1997	Molto Pinol, F

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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